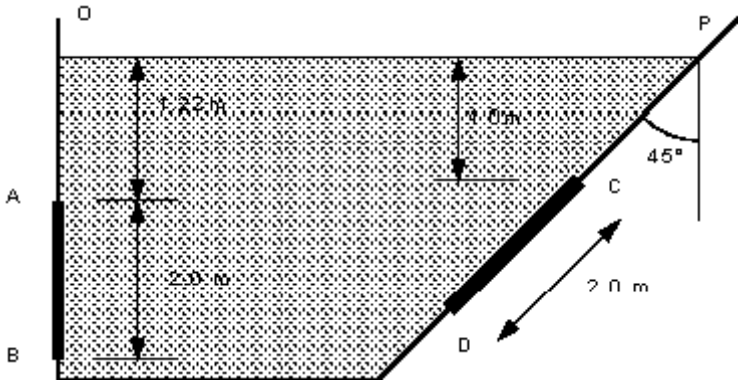
Statics Examples

Pressure and Manometers

1. What will be the (a) the gauge pressure and (b) the absolute pressure of water at depth 12m below the surface? ρ_{water} = 1000 kg/m^3, and p $_{atmosphere}$ = 101kN/m^2.
   [117.72 kN/m^2, 218.72 kN/m^2]
2. At what depth below the surface of oil, relative density 0.8, will produce a pressure of 120 kN/m^2? What depth of water is this equivalent to?
   [15.3m, 12.2m]
3. What would the pressure in kN/m^2 be if the equivalent head is measured as 400mm of (a) mercury γ=13.6 (b) water (c) oil specific weight 7.9 kN/m^3 (d) a liquid of density 520 kg/m^3?
   [53.4 kN/m^2, 3.92 kN/m^2, 3.16 kN/m^2, 2.04 kN/m^2]
4. A manometer connected to a pipe indicates a negative gauge pressure of 50mm of mercury. What is the absolute pressure in the pipe in Newtons per square metre if the atmospheric pressure is 1 bar?
   [93.3 kN/m^2]
5. What height would a water barometer need to be to measure atmospheric pressure?
   [>10m]
6. An inclined manometer is required to measure an air pressure of 3mm of water to an accuracy of +/- 3%. The inclined arm is 8mm in diameter and the larger arm has a diameter of 24mm. The manometric fluid has density 740 kg/m^3 and the scale may be read to +/- 0.5mm.
   What is the angle required to ensure the desired accuracy may be achieved?
   [12 39']
7. Determine the resultant force due to the water acting on the 1m by 2m rectangular area AB shown in the diagram below.
   (On the diagram distance OA is 1.22m and AB is 2.0m)
   [43 560 N, 2.37m from O



8. Determine the resultant force due to the water acting on the 1.25m by 2.0m triangular area CD shown in the figure above. The apex of the triangle is at C.
   (On the diagram depth to point C is 1.0m and the distance CD is 2.0m)
   [23.810^{3}N, 2.821m from P]

Forces on submerged surfaces

1. Obtain an expression for the depth of the centre of pressure of a plane surface wholly submerged in a fluid and inclined at an angle to the free surface of the liquid.
   A horizontal circular pipe, 1.25m diameter, is closed by a butterfly disk which rotates about a horizontal axis through its centre. Determine the torque which would have to be applied to the disk spindle to keep the disk closed in a vertical position when there is a 3m head of fresh water above the axis.
   [1176 Nm]

2. A dock gate is to be reinforced with three horizontal beams. If the water acts on one side only, to a depth of 6m, find the positions of the beams measured from the water surface so that each will carry an equal load. Give the load per meter.
   [58 860 N/m, 2.31m, 4.22m, 5.47m]
3. The profile of a masonry dam is an arc of a circle, the arc having a radius of 30m and subtending an angle of 60 at the centre of curvature which lies in the water surface. Determine (a) the load on the dam in N/m length, (b) the position of the line of action to this pressure.
   [4.28 10^6 N/m length at depth 19.0m]
4. The arch of a bridge over a stream is in the form of a semi-circle of radius 2m. the bridge width is 4m. Due to a flood the water level is now 1.25m above the crest of the arch. Calculate (a) the upward force on the underside of the arch, (b) the horizontal thrust on one half of the arch.
   [263.6 kN, 176.6 kN]
5. The face of a dam is vertical to a depth of 7.5m below the water surface then slopes at 30 to the vertical. If the depth of water is 17m what is the resultant force per metre acting on the whole face?
   [1563.29 kN]
6. A tank with vertical sides is square in plan with 3m long sides. The tank contains oil of relative density 0.9 to a depth of 2.0m which is floating on water a depth of 1.5m. Calculate the force on the walls and the height of the centre of pressure from the bottom of the tank.
   [165.54 kN, 1.15m]